New Hybrid Process for Converting Small Structural Parts from Metal to CFRP

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Abstract : Carbon fibre-reinforced plastic (CFRP) offers outstanding value. However, like all materials, CFRP also has its challenges. Many forming processes are largely manual and hard to automate, making it challenging to control repeatability and reproducibility (R&R); they generate significant scrap and are too slow for high-series production; fibre costs are relatively high and subject to supply and cost fluctuations; the supply chain is fragmented; many forms of CFRP are not recyclable, and many materials have yet to be fully characterized for accurate simulation; shelf life and outlife limitations add cost; continuous-fibre forms have design limitations; many materials are brittle; and small and/or thick parts are costly to produce and difficult to automate. A majority of small structural parts are metal due to high CFRP fabrication costs for the small-size class. The fact that CFRP manufacturing processes that produce the highest performance parts also tend to be the slowest and least automated is another reason CFRP parts are generally higher in cost than comparably performing metal parts, which are easier to produce. Fortunately, business is in the midst of a major manufacturing evolution—Industry 4.0— one technology seeing rapid growth is additive manufacturing/3D printing, thanks to new processes and materials, plus an ability to harness Industry 4.0 tools. No longer limited to just prototype parts, metal-additive technologies are used to produce tooling and mold components for high-volume manufacturing, and polymer-additive technologies can incorporate fibres to produce true composites and be used to produce end-use parts with high aesthetics, unmatched complexity, mass customization opportunities, and high mechanical performance. A new hybrid manufacturing process combines the best capabilities of additive—high complexity, low energy usage and waste, 100% traceability, faster to market—and post-consolidation—tight tolerances, high R&R, established materials, and supply chains—technologies. The platform was developed by Zürich-based 9T Labs AG and is called Additive Fusion Technology (AFT). It consists of a design software offering the possibility to determine optimal fibre layup, then exports files back to check predicted performance—plus two pieces of equipment: a 3d-printer—which lays up (near)-net-shape preforms using neat thermoplastic filaments and slit, roll-formed unidirectional carbon fibre-reinforced thermoplastic tapes—and a post-consolidation module—which consolidates then shapes preforms into final parts using a compact compression press fitted with a heating unit and matched metal molds. Matrices—currently including PEKK, PEEK, PA12, and PPS, although nearly any high-quality commercial thermoplastic tapes and filaments can be used—are matched between filaments and tapes to assure excellent bonding. Since thermoplastics are used exclusively, larger assemblies can be produced by bonding or welding together smaller components, and end-of-life parts can be recycled. By combining compression molding with 3D printing, higher part quality with very-low voids and excellent surface finish on A and B sides can be produced. Tight tolerances (min. section thickness=1.5mm, min. section height=0.6mm, min. fibre radius=1.5mm) with high R&R can be cost-competitively held in production volumes of 100 to 10,000 parts/year on a single set of machines.

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